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Jc135 U.S. PTO
09/25/05
02/19/99

Assistant Commissioner for Patents
Box Patent Applications
Washington D.C. 20231

Attorney Docket No.016907/0957

(must include alphanumeric codes if no inventors named)

UTILITY PATENT APPLICATION TRANSMITTAL
(new nonprovisional applications under 37 CFR 1.53(b))

Transmitted herewith for filing is the patent application of:

INVENTOR(S): Tatsumi MATSUMOTO

TITLE: IMAGE FORMING APPARATUS AND EXPOSURE SCANNING APPARATUS

In connection with this application, the following are enclosed:

APPLICATION ELEMENTS:

XX Specification - 47 TOTAL PAGES

(preferred arrangement:)

- Descriptive Title of the Invention
- Cross Reference to Related Applications
- Statement Regard Fed sponsored R&D
- Reference to Microfiche Appendix
- Background of the Invention
- Brief Summary of the Invention
- Brief Description of the Drawings (if filed)
- Detailed Description
- Claim(s)
- Abstract of the Disclosure

XX Drawings - Total Sheets 8

XX Declaration and Power of Attorney - Total Sheets 1

XX Newly executed (original or copy)

 Copy from a prior application (37 CFR 1.63(d))

(relates to continuation/divisional boxes completed) - NOTE: Box below

 DELETION OF INVENTOR(S) - Signed statement attached deleting inventor(s)
named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).

 Incorporation By Reference (useable if copy of prior application
Declaration being submitted)

The entire disclosure of the prior application, from which a COPY of the
oath or declaration is supplied as noted above, is considered as being
part of the disclosure of the accompanying application and is hereby
incorporated by reference therein.

 Microfiche Computer Program (Appendix)

 Nucleotide and/or Amino Acid Sequence Submission (if applicable,
all necessary)

 Computer Readable Copy

 Paper Copy (identical to computer copy)

 Statement verifying identify of above copies

ACCOMPANYING APPLICATION PARTS

XX Assignment Papers (cover sheet & document(s))

 37 CFR 3.73(b) Statement (when there is an assignee)

 English Translation Document (if applicable)

XX Information Disclosure Statement(IDS) with PTO-1449. 1 Copies of IDS Citations

 Preliminary Amendment

XX Return Receipt Postcard (MPEP 503)

☐ Small Entity Statement(s)
☐ Statement file in prior application, status still proper and desired.
☒ Certified Copy of Priority Document(s) with Claim of Priority
(if foreign priority is claimed).
☒ OTHER: Check for \$800.00

If a CONTINUING APPLICATION, check appropriate box and supply the requisite information:

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP)
of prior application Serial No. .

☐ Amend the specification by inserting before the first line the following sentence: --This application is a continuation, divisional or continuation-in-part of application Serial No. , filed .--

CORRESPONDENCE ADDRESS:

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FEE CALCULATIONS: (Small entity fees indicated in parentheses.)

(1) For	(2) Number Filed	(3) Number Extra	(4) Rate	(5) Basic Fee \$760 (\$380)
Total Claims	11 - 20 =	0	x \$18 (x \$9)	0.00
Independent Claims	2 - 3 =	0	x \$78 (x \$39)	0.00
Multiple Dependent Claims			\$260 (\$130)	0.00
Assignment Recording Fee per property			\$40	40.00
			TOTAL FEE:	\$800.00

METHOD OF PAYMENT:

A check in the amount of the above TOTAL FEE is attached. If payment is enclosed, this amount is believed to be correct; however, the Commissioner is hereby authorized to charge any deficiency or credit any overpayment to Deposit Account No. 19-0741.

Respectfully submitted,

Date: February 19, 1999
Docket No.: 016907/0957



Richard L. Schwaab
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TITLE OF THE INVENTION

IMAGE FORMING APPARATUS AND EXPOSURE SCANNING APPARATUS

BACKGROUND OF THE INVENTION

5 The present invention relates to an image forming apparatus such as a composite-type digital copier that performs image-copying function, facsimile function, printer function and the like, and also relates to an exposure scanning apparatus for use in the image forming apparatus.

10 With a conventional image forming apparatus such as a digital copier, the error in copying magnification may fail to fall within a specified range in the manufacture line. After the image forming apparatus is delivered to a user, it may be demanded that the error
15 in the 100%-magnification be eliminated (that is, the erroneous magnification of $100\% \pm \alpha$ be changed to 100%). In either case the magnification must be adjusted. To this end, the magnification is minutely adjusted in the conventional image forming apparatus.

20 In an image forming apparatus comprising image forming means that has a polygon mirror for performing optical scanning, an error in the image-forming magnification may occur in two systems, i.e., the reading optical system and the laser optical system,
25 which are shown in FIGS. 10 and 11, respectively.

As seen from FIG. 10, an error in the image-forming magnification may occur in the reading optical

system, due to changes in focal distance, which have resulted from inaccurate shapes of the lenses, and due to inaccurate adjusting of the focal distance.

(To achieve accurate positioning of lenses, the lens holder must be a high-precision one. The range over which the focal distance can be adjusted is narrow, making it impossible to impart a completely correct focal distance to the reducing optical system.)

As seen from FIG. 11, an error in the image-forming magnification may occur in the laser optical system, due to inaccurate shapes of the lenses, and inaccurate positioning of the lenses.

Image data generated by the reading optical system that has such error-causing factors as described above is supplied to an image processing circuit. The image processing circuit processes the image data, enlarging or reducing the image represented by the data (by altering the method of reading data from a line memory), thereby minutely adjusting the magnification.

When the error in the image-forming magnification is eliminated by enlarging or reducing the image as above, however, the intervals of sampling image data interfere with the intervals of re-sampling the image data for enlarging or reducing the image. Inevitably, a pattern of alternate dark and light stripes, known as "moire," appear in the image. Moire is particularly conspicuous at a magnification nearly equal to 100%.

It is generated not only in a high-periodicity image such as a halftone image, but also in a low-periodicity image such as a text image.

5 To suppress the moire, the image data may be passed through a low-pass filter, thereby smoothing the image represented by the image data. When data representing a text image is passed through a low-pass filter, however, the resultant text image is blurred.

BRIEF SUMMARY OF THE INVENTION

10 The object of the present invention is to provide an image forming apparatus which form images free of a pattern of alternate dark and light stripes and which forms clear text images, even if the image-forming magnification is minutely adjusted to a correct one,
15 and to provide an exposure scanning apparatus for use in the image forming apparatus.

In order to achieve the object described above, an image forming apparatus according to the present invention comprises: light-emitting means for emitting
20 a light beam in accordance with image data representing pixels arranged in a main scanning direction and a sub-scanning direction; an image carrier for forming an electrostatic image when scanned with the light beam emitted from the light-emitting means; scanning means
25 for scanning the image carrier with the light beam emitted from the light-emitting means, the scanning means including a polygon mirror for reflecting

the light beam; first drive means for rotating the polygon mirror; second drive means for rotating the image carrier, thereby to move a surface of the image carrier in the sub-scanning direction; developing means
5 for applying developer onto the image carrier, thereby to develop the electrostatic image into a visible image; transfer means for transferring the visible image from the image carrier onto an image-forming medium; first speed-changing means for changing a
10 rotational speed of the first drive means in accordance with an error in magnification in the main scanning direction, the error being a size ratio of the visible image transferred onto the image-forming medium to an image printed on a document sheet; and second
15 speed-changing means for changing a rotational speed of the second drive means in accordance with the change in the rotational speed of the first drive means.

Since no reducing/enlarging circuits are used to
20 adjust the magnification minutely, no moire will appear in the image transferred onto the image-forming medium.

An image of a scale is copied on image-forming medium in magnification of 100%. The image, thus copied, is compared with the real scale, thereby
25 finding a dimensional difference between the images compared, i.e., an error in magnification. From the magnification error, thus obtained, there is calculated

a desired speed at which the polygon mirror should be rotated. From the desired speed of the polygon motor, a desired speed is obtained at which the image carrier should be rotated.

5 The image forming apparatus may further comprises:
facsimile means for receiving facsimile data from an
external apparatus and providing the facsimile data
as the image data; third speed-changing means provided
in the first speed-changing means, for changing the
10 rotational speed of the first drive means to a new
rotational speed in accordance with the error in
magnification in the main scanning direction, the error
being a size ratio of the visible image represented
by the facsimile data and transferred onto the image-
15 forming medium; and storage means for storing data
representing the new rotational speed, at which first
drive means should be rotated in order to form an image
represented by the facsimile data.

 That is, the image forming apparatus according
20 to the invention may have means for correcting error
in magnification pertaining to the visible image
represented by the facsimile data.

 Additional objects and advantages of the invention
will be set forth in the description which follows, and
25 in part will be obvious from the description, or may
be learned by practice of the invention. The objects
and advantages of the invention may be realized and

obtained by means of the instrumentalities and combinations particularly pointed out hereinafter.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

5 The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate presently preferred embodiments of the invention, and together with the general description given above and the detailed description of the preferred embodiments given below, serve to explain the principles of the invention.

FIG. 1 is a schematic representation of an image forming apparatus according to the present invention;

FIG. 2 is a diagram showing the operation panel of the image forming apparatus;

15 FIG. 3 is a block diagram illustrating the control system provided in the image forming apparatus;

FIG. 4 is a block diagram illustrating the system for controlling the speeds of the main motor and polygon-mirror driving motor, both provided in the apparatus;

FIG. 5A is a diagram explaining how the main motor and the polygon-mirror driving motor work;

FIG. 5B is a timing chart showing control signals;

FIG. 6A is a diagram showing the resolution in the main scanning direction and the resolution in the sub-scanning direction, both attained in the image forming apparatus;

FIG. 6B is a diagram explaining the print width in the main scanning direction;

FIG. 7 is a flow chart explaining how the reference clock data supplied to the main motor and polygon-mirror driving motor is changed from its initial value of;

FIG. 8 is a diagram depicting an image of a scale, copied at magnification of 100%, and an actual image of the scale;

FIG. 9 is a diagram depicting another image of the scale, copied at magnification of 100%, and an actual image of the scale;

FIG. 10 is a diagram explaining how an error in the image-forming magnification may occur in the reading optical system incorporated in a conventional image forming apparatus; and

FIG. 11 is a diagram explaining how an error in the image-forming magnification may occur in the laser optical system provided in the conventional image forming apparatus.

DETAILED DESCRIPTION OF THE INVENTION

An embodiment of the invention will be described with reference to the accompanying drawings. The embodiment is a composite-type image forming apparatus that can operate as three apparatuses, i.e., a plain paper copier (PPC), a facsimile (FAX), and a printer (GDI: graphics display interface).

FIG. 1 shows the internal structure of a digital copier, which is an example of the composite-type image forming apparatus according to the invention. The digital copier comprises a housing 10, a scanner section 4, a printer section 6. The scanner section 4 and printer section 6 are provided in the housing 10. The scanner section 4 functions as reading means as will be described later, whereas the printer section 6 functions as image forming means.

A document table 12, which is a transparent glass pate, is provided on the top of the housing 10 to support a document sheet D. An automatic document feeder (ADF) 7 is provided on the top of the housing 10, too, to feed a document sheet D onto the document table 12. The ADF 7 can be rotated with respect to the document table 12, between an opened position and a closed position. When rotated to the closed position, the ADF 7 holds a document sheet D in contact with the document table 12.

The ADF 7 comprises a document tray 8, an empty sensor 9, a pickup roller 14, a sheet-feeding roller 15, a pair of aligning rollers 16, and a conveyor belt 18. The document tray 8 is provided to hold document sheets D. The empty sensor 9 is used to detect whether or not the tray 8 holds any document sheets. The pickup roller 14 takes document sheets D, one by one, from the document tray 8. The sheet-feeding

roller 15 is provided to feed document sheets D, one by one, from the pickup roller 14. The aligning rollers 16 are designed to align the leading edge of each document sheet D with a reference line. The conveyor belt 18 extends horizontally, covering almost the entire document table 12.

Document sheets D are placed on the document tray 8, each with its printed surface turned upwards. As the ADF 7 is driven, the pickup roller 14 takes the document sheets D sequentially from the tray 8, first the lowermost (i.e., the last page), then the second lowermost (i.e., penultimate page), and so on. The aligning rollers 16 align each document sheet taken from the tray 8. The conveyor belt 18 conveys the document sheet D from the aligning rollers 16 to a prescribed position on the document table 12. The sheet D lies on the table 12, with its one side contacting the table 12.

The ADF 7 further comprises a sheet-reversing roller 20, a non-reversing sensor 21, a flapper 22, a sheet-ejecting roller 23. The roller 20, sensor 21, flapper 22 and roller 23 are located in that end of the ADF 7 which opposes the aligning rollers 16 across the conveyor belt 18. The belt 18 takes a document sheet D away from the document table 12 after the scanner section 4 has read data from said side of the document sheet D, as will be described later.

The sheet D passes through the flapper 21 and ejected by the sheet-ejecting roller 22 onto a document-ejecting section 24 provided on the upper surface of the ADF 7. To read data from the other side of the document sheet D, the flapper 22 is switched, whereby the roller 20 turns the sheet D upside down. The conveyor belt 18 conveys the sheet D, thus turned, to the prescribed position on the document table 12. This time, the sheet D lies on the table 12, with its other side contacting the document table 12.

The scanner section 4, which is provided in the housing 10, has an exposure lamp 25 and a first mirror 26. The exposure lamp 25 is the source of light which illuminates that side of a document sheet D which contacts the document table 12. The first mirror 26 receives the light reflected from that side of the document sheet D and deflects the light in a predetermined direction. Both the exposure lamp 25 and the first mirror 26 are secured to a first carriage 27, which is located below the document table 12. The first carriage 27 is connected to a toothed belt (not shown), which is driven by a motor 38. Hence, the first carriage 27 can be driven back and forth, in parallel to the document table 12.

A second carriage 28 is provided below the document table 12. The second carriage 28 is connected to the toothed belt, like the first carriage 27.

The second carriage 28 can therefore be driven in parallel to the document table 12, at half the speed the first carriage 27 is driven. The second carriage 28 holds a second mirror 30 and a third mirror 31.

5 The surfaces of these mirrors 30 and 31 incline to each other at right angles. The second mirror 30 deflects the light deflected by the first mirror 26. The third mirror 31 deflects the light deflected by the second mirror 30.

10 Image-forming lenses 32 and a CCD sensor 34 are arranged below the document table 12. The image-forming lens 32 focuses the light deflected by the third mirror 31 mounted on the second carriage 28. The image-forming lens 32 can moved by a drive mechanism (not
15 shown), in a plane containing the axis of the light deflected by the third mirror 31. Thus, the lens 32 can therefore form an image in various magnifications, on the light-receiving surface of the CCD sensor 34. The CCD sensor receives the light focused by the lens
20 32 and converts the light into an electric signal. The electric signal represents the data printed on the side of the document sheet D, which the scanner section 4 has scanned.

25 The printer section 6 comprises a laser exposure device 40, which works as a scanning device. The laser exposure device 40 comprises a semiconductor laser 41, a polygon mirror 36, a polygon-mirror driving motor 37,

and a laser optical system 42. The laser 41 is the light source. The polygon mirror 36 is a scanning member for continuously deflecting a laser beam emitted from the semiconductor laser 41. The motor 37 rotates the polygon mirror 36 at a predetermined rotational speed. The laser optical system 42 deflects the laser beam deflected by the polygon mirror 36, guiding the laser beam to a photosensitive drum 44, which will be described later. The laser exposure device 40, thus constructed, is held by a support frame (not shown) that is provided in the housing 10.

The semiconductor laser 41 is turned on or off in accordance with the image data, the scanner section 4 has read from the document sheet D. The polygon mirror 36 and the laser optical system 42, both arranged in the laser exposure device 40, guides and applies the laser beam to the photosensitive drum 44, scanning the circumferential surface of the drum 44. An electrostatic latent image is thereby formed on the circumferential surface of the photosensitive drum 44.

The photosensitive drum 44 is incorporated in the c as an image holder, and is located substantially in the center part of the housing 10. In operation, the drum 44 is rotated by a main motor 77. As the drum 44 is so rotated, its circumferential surface moves in a sub-scanning direction. While moving so,

the circumferential surface of the drum 44 is scanned with the laser beam applied by the laser exposure 40. As a result, an electrostatic latent image is formed on the drum 44 as is desired.

5 A main charger 45, a developing device 46, a separation charger 47, a transfer charger 48, separation claws 49, a cleaner 50, and a discharger 51 are arranged in the order mentioned, around the photosensitive drum 44. The main charger 45 changes
10 the circumferential surface of the drum 44 to a predetermined potential before an electrostatic latent image is formed on the circumferential surface of the drum 44. The developing device 46 applies toner (i.e., developer) to the electrostatic latent image
15 formed on the drum 44, thereby forming a toner image in a desired density. The separation charger 47 and the transfer charger 48 are formed integral in one unit. The separation charger 47 is designed to separate a copy sheet P (image-forming medium) from
20 the photosensitive drum 44. The transfer charger 48 is designed to transfer the toner image from the drum 44 to the copy sheet P. The separation claws 49 are provided to separate the copy sheet P from the circumferential surface of the drum 44. The cleaner 50
25 removes residual toner from the circumferential surface of the drum 44, cleaning the photosensitive drum 44. The discharger 51 is designed to electrostatically

discharge the circumferential surface of the drum 44. The photosensitive drum 44 and the developing roller (not shown) incorporated in the developing device 46 are rotated by the main motor 77.

5 Three paper cassettes 52, 53 and 54 are provided in the lower part of the housing 10, one below another in the order mentioned. The paper cassettes 52, 53 and 54 are can be drawn out of the housing 10. They contain three stacks of copy sheets P, respectively.

10 The copy sheets P contained in each cassette are of the same size, which is different from the size of the sheets P contained in any other cassette. A large-capacity sheet feeder 55 is located beside the paper cassettes 52, 53 and 54. The sheet feeder 55

15 can hold about 3,000 copy sheets P at a time, which are of the most frequently used size, e.g., A4-size. A feeder-cassette 57 is removably provided, right above the large-capacity sheet feeder 55. The feeder-cassette 57 serves as a manual feeding tray 56, as well.

20 A sheet-conveying path 58 is provided in the housing 10. The sheet-conveying path 58 extends from the sheet cassettes 52, 53 and 54 and the feeder 55. The path 58 passes through the image transfer section that is located between the photosensitive drum 44

25 and the transfer charger 48. At the end of the sheet-conveying path 58, a fixing device 60 is arranged. The fixing device 60 comprises a lamp 60a and a heat

roller 60b. The lamp 60a is provided to apply heat to the heat roller 60b. The fixing device 60 opposes a side wall of the housing 10, which has a sheet outlet slot 61. A single-tray finisher 150 is provided
5 outside the housing 10 and attached to said side wall, to receive any copy sheet P conveyed outwardly through the sheet outlet slot 61.

Three pickup rollers 63 are provided at the sheet cassettes 52, 53 and 54, respectively. Another pickup
10 roller 63 is provided at the large-capacity feeder 55. Each pickup roller 63 takes copy sheets P, one by one, from the cassette or the feeder. Several pairs of sheet-conveying rollers 64 are arranged on the sheet-conveying path 58, for conveying a copy sheet P any
15 pickup roller 63 has taken from the associated cassette or feeder.

A pair of register rollers 65 are provided on the sheet-conveying path 58, at the upstream of the photosensitive drum 44, for aligning the leading edge
20 of a copy sheet P with the leading edge of the toner image formed on the circumferential surface of the drum 44. The rollers 65 rotate to feed the copy sheet P to the image transfer section, at the same speed as the circumferential speed of the drum 44.
25 A pre-aligning sensor 66 is located on the sheet-conveying path 58, in the vicinity of the uppermost pair of sheet-conveying rollers 64. The sensor 66

detects whether or not a copy sheet P has reached the register rollers 65.

Any copy sheet P that each pair of pickup rollers 63 have taken from the associated cassette or feeder is conveyed by the sheet-conveying rollers 64 to the pair of register rollers 65. The register rollers 65 align the leading edge of a copy sheet P with the leading edge of the toner image formed on the drum 44. The copy sheet P thus registered is conveyed to the image transfer section.

In the image transfer section, the transfer charger 48 transfers the toner image from the circumferential surface of the drum 44 to the copy sheet P. The copy sheet P is separated from the circumferential surface of the drum 44 by means of the separation charger 47 and separation claws 49. The copy sheet P is then conveyed to the fixing device 60 by a conveyor belt 67, which is a component of the sheet-conveying path 58. The fixing device 60 applies heat to the copy sheet P, melting the toner and fixing the toner image. The copy sheet P is conveyed from the fixing device 60 by a pair of sheet-conveying rollers 68 provided in the housing 10. Finally, it is ejected into the finisher 150 from the housing 10 through the sheet outlet slot 61, by means of a pair of sheet-ejecting rollers 69 provided in the housing 10. A sheet sensor 62 is provided in the housing 10,

adjacent to the sheet-ejecting rollers 69, for detecting a copy sheet P being ejected into the finisher 150.

5 An automatic sheet-reversing device 70 is provided below the sheet-conveying path 58, for reversing a copy sheet P conveyed from the fixing device 60 and conveying the sheet P back to the register rollers 65. The sheet-reversing device 70 comprises a temporary storage section 71, a sheet-reversing passage 72, a pickup roller 73, and a pair of
10 sheet-conveying rollers 75. The storage section 71 stores copy sheets P temporarily. The sheet-reversing passage 72 branches from the sheet-conveying path 58, for reversing a copy sheet P conveyed from the fixing
15 device 60 and guiding the same to the temporarily storage section 71. The pickup roller 73 takes copy sheets P, one by one, from the storage section 71. The sheet-conveying rollers 75 convey a copy sheet P from the pickup roller 73 to the register rollers 65
20 through a sheet passage 74. At the junction between the sheet-conveying path 58 and the sheet-reversing passage 72, a sorting gate 76 is provided for guiding a copy sheet P to either the sheet outlet slot 61 or the sheet-reversing passage 72.

25 To copy data on the other side of a copy sheet P which has data already copied on one side, the copy sheet P is conveyed from the fixing device 60 to

the sorting gate 76. The sorting gate 76 guides
the sheet P into the sheet-reversing passage 72.
As the sheet P is conveyed through the passage 72,
it is reversed. The sheet P thus reversed is stored
5 in the temporary storage section 71 for some time.
The pickup roller 73 and sheet-conveying rollers 75
convey the copy sheet P from the storage section 71 to
the register rollers 65 through the sheet passage 74.
The register rollers 75 register the copy sheet P,
10 which is conveyed again to the image transfer section.
In the image transfer section, a toner image is
transferred from the drum 44 to the other side of
the copy sheet P. The copy sheet P is then conveyed
through the sheet-conveying path 58, passes through the
15 fixing device 60, and is ejected into the finisher 150
by the sheet-ejecting rollers 69.

The finisher 150 accumulates copy sheets P that
should be stapled together to form a copy of document.
Each copy sheet P ejected into the finisher 150 through
20 the sheet outlet slot 61 is aligned with the other
sheets P already accumulated in the finisher 150.
When all sheets P forming the document are aligned
with one another, an arm 152 holds them together, and
a stapler unit (not shown) staples the copy sheets P,
25 thus forming a copy of document. Thereafter, the guide
bar 151 is lowered, and the copy of document is ejected
from the finisher 150 onto a finisher tray 154 by means

of a document-ejecting roller 155.

The finisher tray 154 is lowered stepwise, each time by a distance determined by the number of copy sheets P that form a copy of document. The guide bar 151 is located at such a level that it remains out of contact with the copy of document laid on the finisher tray 154.

The finisher tray 154 is connected to a tray-shifting mechanism (not shown). The tray-shifting mechanism shifts the finisher tray 154 forward, backward, leftward or rightward in document-sorting mode, every time one copy of document is laid on the finisher tray 154.

An operation panel 80 is provided on the upper-front part of the housing 10. The panel 10 is operated to input and set various copying conditions such as the number of copies that should be made and the magnification in which data should be copied, to designate a part of the document sheet, which should be copied, and to generate a copying start signal.

As FIG. 2 shows, the operation panel 80 has a ten-key pad 81, a copy key 82, indicators 83, a liquid crystal display 84, document size keys 85, sheet size keys 86, a density indicator 87, a density key 88, a reduction key 89a, a 100%-magnification key 98b, and an enlargement key 89c.

The ten-key pad 81 is operated to input and set

various values, such as the number of copies that should be made. The copy key 82 is pushed to start copying. The indicators 83 are provided to indicate which sheet cassette is selected and whether a document sheet D or a copy sheet P is jamming or not.

The liquid crystal display 84 is designed to display various items of information, such as the number of copies that should be made and the magnification in which data should be copied.

The liquid crystal display 84 functions as a touch panel, too. When a user touches any keys displayed, the instructions assigned to these keys are input. Further, the liquid crystal display 84 can call specific mode, which an operator can minutely adjust the magnification of the digital copier after the assembling thereof.

The document size keys 85 are depressed to set various sizes of document sheets D. The copy sheet size keys 86 are depressed to set various sizes of copy sheets P. The density indicator 87 indicates the copy density that has been set by operating the density key 88.

The reduction key 89a is pushed to decrease the magnification to any value ranging from 99% to 50%, in units of 1%. The 100%-magnification key 98b is depressed to set the magnification at 100%. The enlargement key 89c is pushed to increase

the magnification to any value ranging from 101% to 400%, in units of 1%.

FIG. 3 is a block diagram of the control system incorporated in the digital copier shown in FIG. 1, and schematically depicts the electrical connection of the components of the copier and the flow of various control signals.

The control system comprises a main CPU 91, a scanner CPU 100 and a printer CPU 110. As shown in FIG. 3, the main CPU 91 is incorporated in a main control section 90. The scanner CPU 100 is provided in the scanner section 4. The printer CPU 110 is provided in the printer section 6. Data is exchanged between the main CPU 91 and the printer CPU 110 through a common RAM 95 that is incorporated in the main control section 90. The main CPU 91 gives instructions to the printer CPU 110, which gives operation statuses to the main CPU 91.

Serial communication is achieved between the printer CPU 110 and the scanner CPU 100. The printer CPU 110 gives instructions to the scanner CPU 100, which gives operation statuses to the printer CPU 110. The digital copier may have a facsimile section 131 as an optional function. If so, the facsimile section 13 is connected to the main CPU 91 by a facsimile interface 130 provided in the main control section 90.

The main control section 90 comprises a ROM 92,

a RAM 93, an NVM (Nonvolatile RAM) 94, an image-processing section 96, a page memory controller 97, a page memory 98, a printer controller 99, a printer font ROM 121, a horizontal sync signal generator 123, and an image-transfer clock generator 124, in addition to the main CPU 91, common RAM 95 and facsimile interface 130.

The main CPU 91 is used to control the other components of the main control section 90. The ROM 92 stores various control programs. The RAM 93 is provided to store data temporarily.

The NVM 94 is a nonvolatile memory to which power is supplied from a battery (not shown). The NVM 94 therefore keep holding the data it has stored, after the power supply switch to the digital copier is turned off. The NVM 94 has an initial value table 94a. The table 94 stores the default values of the polygon mirror 36 and initial values of the main motor 77, which have been set for the different resolutions prescribed for the image sources of copier (PPC) function, facsimile (FAX) function and printer (GDI) function. The common RAM 95 is provided to accomplish communication between the main CPU 91 and the printer CPU 110.

The image-processing section 96 comprises an image-processing circuit and a line memory 96a. The image-processing circuit performs various processes,

such as trimming, masking, compression, and expansion, on image data. The image data processed by the image-processing circuit is stored in the line memory 96a.

5 The printer font ROM 121 stores font data that corresponds to code data such as character codes.

10 The printer controller 99 receives code data (e.g., character codes) from an external apparatus 122 (e.g., a personal computer). The code data includes data representing a specific character size and particular resolution. From the code data the controller 99 generates image data having the character size and the resolution, with reference to the font data stored in the printer font ROM 121.

15 The horizontal sync signal generator 123 generates a horizontal sync signal that is synchronous with the rotation of the polygon mirror 36. The image-transfer clock generator 124 generates an image-transfer clock signal for controlling the timing of transferring image data.

20 The page memory controller 97 is provided to write image data into, and read the image data from, the page memory 98. The page memory 98 has a storage area for storing a plurality of pages of data. Compressed image data is supplied from the scanner section 4 to the page memory 98. The page memory 98 stores the compressed
25 image data, in units of pages.

The scanner section 4 comprises the scanner

CPU 100, a ROM 101, a RAM 102, a CCD driver 103,
a scanner motor driver 104, and an image-correcting
section 105. The scanner CPU 100 controls all other
components of the scanner section 4. The ROM 101
5 stores control programs. The RAM 102 stored data
temporarily. The CCD driver 103 drives the CCD
sensor 34. The scanner motor driver 104 controls
the rotational speed of the motor 38, which moves
the first carriage 27 and the second carriage 28.
10 It should be recalled that the first carriage 27
holds the exposure lamp 25 and first mirror 26 and
the second carriage 28 holds the second mirror 30
and third mirror 3.

The image-correcting section 105 comprises
15 an A/D converter, a shading-correcting circuit,
a gamma-correcting circuit, and a line memory 105a.
The A/D converter receives an analog signal from the
CCD sensor 34 and converts the signal to a digital
signal. The shading-correcting circuit and gamma-
20 correcting circuit compensate for changes in the
threshold level for the digital signal supplied from
the A/D converter. The line memory 105a temporarily
stores the digital signal thus corrected by the
shading-correcting circuit and gamma-correcting circuit.
25 The image-correcting section 105 further comprises
an exposure lamp controller (not shown) and a driver
(not shown, either). The exposure lamp controller

controls the image-correcting section 105. The driver drives a mechanism, which moves the image-forming lens 32 so that the magnification, in which data should be copied, may be adjusted to a desired value.

5 The printer section 6 comprises the printer CPU 110, a ROM 111, a RAM 112, an LD drive circuit 113, a polygon motor drive circuit 114, a sheet-conveying section 115, a development process section 116, a fixing control section 117, an option section 118, 10 and main motor drive circuit 119. The printer CPU 110 controls all other components of the printer section 6. The ROM 111 store control programs. The RAM 112 is provided for storing data. The LD drive circuit 113 turns the semiconductor laser 41 on and off. The 15 polygon motor drive circuit 114 controls the rotational speed of the polygon motor incorporated in the laser unit 40. The sheet-conveying section 115 controls the conveyance of copy sheets P through the sheet-conveying path 58. The development process section 116 20 cooperates with the main charger 45, developing device 46, transfer charger 48 and the like, to charging the drum 44, develop a toner image on the drum 44, and transfer the toner image from the drum 44 to a copy sheet P. The fixing control section 117 controls the 25 fixing device 60. The main motor drive circuit 119 controls the sheet sensor 62, pre-aligning sensor 66 and option section 118. The circuit 119 controls

the rotational speed of the main motor 77, too.

As shown in FIG. 4, the polygon motor drive circuit 114 has an IC (Integrated Circuit) 114a for controlling the polygon-motor driving motor 37.

5 The IC 114a receives a reference clock data REF-CLK 1 from the main CPU 91 and generates an FG pulse signal having a motor-driving frequency, and the pulse signal is supplied to the polygon-mirror driving motor 37, controlling the rotational speed of the motor 37.

10 As shown in FIG. 4, too, the main motor drive circuit 119 has an IC 119a for controlling the main motor 77. The IC 119a receives a reference clock data EF-CLK 2 from the main CPU 91 and generates an FG pulse signal having a motor-driving frequency, and the pulse
15 signal is supplied to the main motor 77, controlling the rotational speed of the main motor 77.

The facsimile section 131 receives facsimile data generated by compressing bit-map data transmitted from an external apparatus through a communication line such
20 as the public telephone line. The facsimile section 131 converts the facsimile data to image data, which is supplied to the main control section 90 through the facsimile interface 130.

The image-processing section 96, page memory
25 controller 97, page memory 98, printer controller 99, image-correcting section 105 and LD drive circuit 113 are connected by a data bus 120.

How the rotational speeds of the polygon mirror 36 and photosensitive drum 44 are controlled will be explained, with reference to the block diagram of FIG. 4, the mechanism diagram of FIG. 5A and the timing chart of FIG. 5B.

To copy the data printed on a document sheet D, the main CPU 91 generates a control signal ON/OFF1 and a reference clock data REF-CLK1 in accordance with a control program stored in the ROM 92. The control signal ON/OFF1 is supplied to the polygon motor drive circuit 114, causing the circuit 114 to start driving the polygon-mirror driving motor 37. The reference clock data REF-CLK1 is supplied to the polygon motor drive circuit 114, for controlling the rotational speed of the motor 37. The main CPU 91 also generates a control signal ON/OFF2 and a reference clock data REF-CLK2. The control signal ON/OFF2 is supplied to the main motor drive circuit 119, causing the circuit 119 to start driving the main motor 77. The reference clock data REF-CLK2 is supplied to the circuit 119, for controlling the rotational speed of the motor 77.

In the polygon motor drive circuit 114, the control signal ON/OFF1 is supplied to the IC 114a. The IC 114a generates an FG pulse signal having a motor-driving frequency. The FG pulse signal is supplied to the polygon-mirror driving motor 37 and controls the rotational speed of the motor 37.

The rotational speed of the polygon mirror 36 is therefore controlled. When the rotational speed of the polygon mirror 36 becomes stable at the value corresponding to the reference clock data REF-CLK1, the signal PLL1 generated by the IC 114a and supplied to the main CPU 91 is enabled (for example, rising to high level). The main CPU 91 determines, from the signal PLL1, that the rotational speed of the polygon mirror 36 has become stable.

In the main motor drive circuit 119 that has received the control signal ON/OFF2 from the main CPU 91, the IC 119a provided to control the main motor 77 generates an FG pulse signal having a motor-driving frequency. The FG pulse signal is supplied to the main motor 77 and controls the rotational speed of the motor 77. The rotational speed of the photosensitive drum 44 is therefore controlled. When the speed of the drum 44 becomes stable at the value corresponding to the reference clock data REF-CLK2, the signal PLL2 generated by the IC 119a and supplied to the main CPU 91 is enabled. The main CPU 91 determines, from the signal PLL1, that the rotational speed of the photosensitive drum 44 has become stable.

Upon receipt of the signals PLL1 and PLL2 which have been supplied from the polygon motor drive circuit 114 and main motor drive circuit 119, respectively, and which have been enabled, the main CPU 91 causes

the CCD sensor 34 to scan the document sheet D placed on the document table 12. The CCD sensor 34 reads the image printed on the document sheet D and converts the same to image data. The image data is supplied to the scanner section 4. In the scanner section 4, the image-correcting section 105 performs shading correction, gamma correction and the like on the image data. One line of image data is stored into the line memory 105a.

If the digital copier receives facsimile data transmitted from an external apparatus through the public telephone line, the facsimile section 131 compresses or expands the facsimile data, thereby generating image data having a prescribed resolution.

The image data is stored into the line memory 96a provided in the image-processing section 96. To print an image represented by the code data input from the external apparatus 122, the printer controller 99 converts the code data to dot-character image data, with reference to the font data stored in the printer font ROM 121. The dot-character image data is stored, line by line, into the line memory 96a provided in the image-processing section 96.

The image data is output to the LD drive circuit 113 from the line memory 105a incorporated in the image-correcting section 105, in synchronism with the image-transfer clock signal supplied from

the image-transfer clock generator 124. The image data output from the LD drive circuit 113 is supplied to the semiconductor laser 41. The laser 41 generates a laser beam from the image data. As shown in FIG. 5A, the polygon mirror 36 reflects the laser beam, applying the beam to the image-forming area of the photosensitive drum 44.

The laser beam reflected by the polygon mirror 36 is applied to a light-receiving element 43 that is located outside the image-forming area of the drum 44 as shown in FIG. 5A. Upon receipt of the laser beam, the element 43 generates a horizontal sync signal as is illustrated in FIG. 5B.

The image-transfer clock generator 124 generates an image-transfer clock signal CLK. The image-transfer clock signal CLK is synchronous with the horizontal sync signals which the light-receiving element 43 and horizontal sync signal generator 123 have generated in synchronism with the rotation of the polygon mirror 35.

There are two main causes of an error in image-forming magnification. The first is an error in the reading optical system shown in FIG. 10. The second is an error in the laser optical system 42 shown in FIG. 11.

One error that may occur in the reading optical system is an incorrect focal distance which results, as shown in FIG. 10, from the inadequate positioning of

the image-forming lens 32. Another error that may occur in the reading optical system is an insufficient shape of the lens 32.

5 One error that may occur in the laser optical system 42 is incorrect shape and/or positioning of the polygon mirror 36. Another error that may occur in the system 42 is incorrect shape and/or positioning of the lenses and mirrors.

10 Assume an error of (400) dpi (dots per inch) occurs while printing an image having a width W, as shown in FIGS. 6A and 6B, in resolution of 400 dpi (dots per inch) in both the main scanning direction and the sub-scanning direction. In this case, the magnification in the main scanning direction depends on
15 the rotational speed of the polygon mirror 36. Namely, if the rotational speed of the mirror 36 is raised from a preset value, the magnification will increase and, hence, the width W (FIG. 6B) will become longer. Conversely, if the rotational speed of the mirror 36 is
20 lowered from a preset value, the magnification will decrease and, hence, the width W (FIG. 6B) will become shorter.

25 The IC 114a incorporated in the polygon motor drive circuit 114 determines the rotational speed of the polygon-motor driving motor 37 on the basis of the reference clock data REF-CLK1. The clock signal REF-CLK1 has been generated the main CPU 91

in accordance with the default values of the polygon mirror 36 which are stored in the initial value table 94a. The frequency of the reference clock data REF-CLK1 is changed, whereby the FG pulse signal that the IC 114a generates is changed in terms of its motor-driving frequency. The FG pulse signal is supplied to the polygon-mirror driving motor 37, thereby changing the rotational speed of the polygon mirror 36.

10 The initial frequency for the reference clock data REF-CLK1 is stored in the initial value table 94a provided in the NVM 94. In other words, the initial frequency has been written into the internal register of the main CPU 91 and is used, whenever necessary, to drive the polygon-mirror driving motor 37.

15 The frequency F_v [MHz] of the FG pulse signal supplied to the motor 37, the rotational speed N_p [rpm] of the polygon-mirror driving motor 37, and the image resolution $R_p(H)$ [dots/mm] in the main scanning direction have the following relation:

$$F_v = 10^{-6} \times R_p(H) \times V \quad \dots (1a)$$

The scanning speed V [mm/s] is given as follows:

$$V = (2 \times N_p / 60) \times 2\pi \times f \quad \dots (1b)$$

25 where N_p is the rotational speed [rpm] of the polygon-mirror driving motor 37 and f is the value [mm/rad] of $f\theta$ characteristic.

On the basis of the equations (1a) and (1b),

the rotational speed N_p of the motor 37 can be represented as follows:

$$F_v = 10^{-6} \times R_p(H) \times 4\pi \times (N_p/60) \times f$$

$$\therefore N_p = 60 \times F_v \times 10^{-6} / (4\pi \times R_p(H) \times f) \quad \dots (1)$$

As can be understood from the equation (1), the rotational speed of the polygon-mirror driving motor 37 is changed by varied the motor-driving frequency F_v . That is, the magnification in the main scanning direction can be changed.

The magnification in the sub-scanning direction, i.e., the resolution $R_p(V)$, depends on the rotational speed N_p of the polygon-mirror driving motor 37. If the magnification in the main scanning direction is adjusted by changing the rotational speed N_p only, without changing the rotational speed of the photosensitive drum 44, an error will be made in the magnification in the sub-scanning direction. It follows that the rotational speed of the main motor 77 must be changed to alter the rotational speed of the drum 44, when the rotational speed of the polygon-mirror driving motor 37 is changed.

The circumferential speed V_p [mm/s] of the drum 44 is given as follows:

$$N_p = 60 \times V_p \times R_p(V) / N/n$$

$$\therefore V_p = \{(N_p \times N) / (60 \times R_p(V))\} / n \quad \dots (2)$$

where N_p is the rotational speed [rpm] of

the polygon-mirror driving motor 37, $R_p(V)$ is
the resolution [dots/mm] in the sub-scanning direction,
N is the number of faces the polygon mirror 36 has,
and n is the number of laser beams applied to the
5 drum 44.

Thus, the main CPU 91 generates a reference clock
data REF-CLK2 that has such a frequency as to rotate
the photosensitive drum 44 at the circumferential speed
Vp defined above. More precisely, the main CPU 91
10 rewrites the reference clock data stored in the initial
value (default) table 94a provided in the NVM 94.
The reference clock data REF-CLK2 is supplied to the
main motor drive circuit 119.

In the main motor drive circuit 119, the IC 119a
15 provided to control the main motor 77 alters the motor-
driving frequency of the FG pulse signal. The FG pulse
signal is supplied to the main motor 77, changing
the rotational speed of the motor 77. The rotational
speed of the photosensitive drum 44 is thereby changed.
20 As a result, the resolution in the sub-scanning
direction is changed.

As described above, the rotational speed of the
polygon-mirror driving motor 37 and the rotational
speed of the main motor 77 are changed by changing the
25 reference clock data REF-CLK1 and REF-CLK2. Therefore,
the magnification in the main scanning direction can
adjusted to a desired value, and the error in

the magnification in the sub-scanning direction,
inevitably made due to the adjustment of the magnifi-
cation, can be eliminated. Hence, the magnification
can be minutely adjusted in the process of forming
5 a 100%-magnification image on a copy sheet P (image-
forming medium). Since no reducing/enlarging circuits
are used to adjust the magnification minutely, no moire
will appear in the image formed on the copy sheet P.

How the magnification is minutely adjusted in the
10 process of forming a 100%-magnification image will be
explained, with reference to the flow chart of FIG. 7
and also with FIGS. 8 and 9.

Assume that it is necessary to adjust the
magnification to provide a 100%-magnification copy of
15 the data printed on a document sheet D, while the
digital copier remains in the assembly line. In this
case, an operator lays a scale S on the document
table 12, aligning the scale S in the main scanning
direction, as is illustrated in FIG. 8. A 100%-
20 magnification image of the scale S is copied (Step ST1).
The operator compares the 100%-magnification image
with the real scale S in terms of size, calculating
a dimensional ratio of the image to the scale S.
In other words, an error in magnification is determined
25 (Step ST2).

If the error determined exceeds a tolerable
maximum value, the operator operates the panel 80,

setting the digital copier into adjustment mode. Then,
the operator operates the ten-key pad 81 on the panel
80, inputting data representing the motor-driving
frequency that corresponds to the magnification error
5 (Step ST3). In accordance with the data input, the CPU
91 changes the initial value (default) for the clock
data REF-CLK1 (Step ST4) which is stored in the initial
value table 94a provided in the NVM 94.

When the rotational speed of the polygon-mirror
10 driving motor 37 is changed, the main CPU 91 calculates
the circumferential speed of the photosensitive drum 44
in accordance with the equation (2). From the
circumferential speed of the drum 44, thus obtained,
the main CPU 91 calculates the frequency data of the
15 reference clock data REF-CLK2 to be supplied to the
main motor drive circuit 119 (Step ST5).

The main CPU 91 rewrites the initial frequency data
for the data REF-CLK2, which is stored in the initial
value table 94a, to the frequency data calculated in
20 Step ST5 (Step ST6). The magnification is thereby
minutely adjusted.

As indicated above, the operator calculate a
frequency for a reference clock data. Instead, the
main CPU 91 may calculate the frequency from the ratio
25 which the operator has input by operating the ten-key
pad 81 and which represents a magnification error.

As described above, the magnification is minutely

adjusted in the process of forming a 100%-magnification image on a copy sheet P, by changing both the main-scanning speed and the sub-scanning speed. Therefore, no moire appears in the image formed on the copy sheet P.

The magnification for the image represented by facsimile data transmitted from an external apparatus is minutely adjusted in the following manner. First, the facsimile section 131 receives facsimile data transmitted from the external apparatus and representing an image of a scale. An image of the scale is then formed on a copy sheet P. The image is compared with an original image of the scale, which has been read at the external apparatus, and a dimensional ratio of the images, i.e., an error in magnification is calculated. From the magnification error, thus determined, the rotational speeds of the polygon-mirror driving motor and main motor are calculated and stored, as values for the facsimile function, into the initial value table 94a.

The magnification in which an image is to be printed under the control of the printer controller 99 is minutely adjusted in the following manner. First, a code data served as an image of a scale and supplied from an external apparatus is supplied to the printer controller 99. The controller 99 decodes the code data, generating dot image data. The image data is

processed, forming an image of the scale. The image is compared with an exactly life-size image of the scale, thereby determining a dimensional ratio of the images compared, i.e., an error in magnification. From the magnification error, thus determined, the rotational speeds of the polygon-mirror driving motor and main motor are calculated and stored, as values for the printer function, into the initial value table 94a.

In the digital copier described above, an error in the magnification in the main scanning direction is calculated. The rotational speed of the polygon-mirror driving motor is changed in accordance with this magnification error. The rotational speed of the main motor is changed in accordance with the change in the rotational speed of the polygon-mirror driving motor, thereby minutely adjusting the magnification in the main and sub-scanning direction. Instead, an error in the magnification in the sub-scanning direction may be calculated first as is illustrated in FIG. 9. In this case, the rotational speed of the main motor is changed in accordance with the error in the magnification in the sub-scanning direction. The rotational speed of the polygon-mirror driving motor is then changed in accordance with the change in the rotational speed of the main motor, thus minutely adjusting the magnification in the main and sub-scanning direction.

As has been described, the reference clock data

for the polygon-mirror driving motor 73 is calculated while the digital copier remains in the assembly line. The calculated reference clock data corresponds to an error in the magnification in which a 100%-
5 magnification copy is to be provided. Therefore, the rotational speed of the polygon-mirror driving motor 37 is adjusted. The rotational speed of the main motor 77 is adjusted in accordance with the adjusted rotational speed of the polygon-mirror driving motor 37.
10 The magnification in which a 100%-magnification copy should be provided can therefore be minutely adjusted.

As has been described above, different frequencies can be set for reference clock data which will be used to process image data items supplied from different
15 sources such as the printer controller and an external facsimile apparatus. The magnifications of the images represented by these image data items can therefore be minutely adjusted independently. Thus, the present invention can provide an image forming apparatus which
20 form images free of a pattern of alternate dark and light stripes and which forms clear images, even if the image-forming magnification is minutely adjusted to a correct one.

Additional advantages and modifications will
25 readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and representative embodiments

shown and described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.

100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000

CLAIMS

1. An image forming apparatus comprising:

light-emitting means for emitting a light beam in
accordance with image data representing pixels arranged
5 in a main scanning direction and a sub-scanning
direction;

an image carrier for forming an electrostatic
latent image when scanned with the light beam emitted
from the light-emitting means;

10 scanning means for scanning the image carrier with
the light beam emitted from the light-emitting means,
said scanning means including a polygon mirror for
reflecting the light beam;

first drive means for rotating the polygon mirror;

15 second drive means for rotating the image carrier,
thereby to move a surface of the image carrier in the
sub-scanning direction;

developing means for applying developer onto the
image carrier, thereby to develop the electrostatic
20 latent image into a visible image;

transfer means for transferring the visible
image from the image carrier onto an image-forming
medium;

25 first speed-changing means for changing a rota-
tional speed of the first drive means in accordance
with an error in magnification in the main scanning
direction, said error being determined from a size

ratio of the visible image transferred onto the
image-forming medium to an original document image; and

second speed-changing means for changing
a rotational speed of the second drive means in
5 accordance with the change in the rotational speed
of the first drive means.

2. An apparatus according to claim 1, wherein the
first drive means has clock input means for inputting
a reference clock data and rotates the polygon mirror
10 at a speed corresponding to the reference clock data,
and the first speed-changing means has data input means
for inputting data representing the reference clock
corresponding to the error.

3. An apparatus according to claim 1, further
15 comprising data-reading means for optically reading
data printed on the document sheet and for providing
the data, thus read, as said image data.

4. An apparatus according to claim 1, which
further comprises facsimile means for receiving
20 facsimile data from an external apparatus and providing
the facsimile data as said image data, and in which
the first speed-changing means has:

third speed-changing means for changing the
rotational speed of the first drive means to a new
25 rotational speed in accordance with an error in
magnification in the main scanning direction, said
error being determined from a size ratio of the visible

image represented by the facsimile data and transferred onto the image-forming medium to an original document image; and

5 storage means for storing data representing the new rotational speed as data at which first drive means should be rotated in order to form an image represented by the facsimile data.

10 5. An apparatus according to claim 1, which further comprises printer control means for receiving code data from an external apparatus, processing the code data into font data representing characters having a size represented by character size data added to the code data and providing the front data as said image data, and in which the first speed-changing means has:

15 third speed-changing means for changing the rotational speed of the first drive means to a new rotational speed in accordance with an error in magnification in the main scanning direction, said error being determined from a size ratio of a size of character in the visible image represented by the code data transferred onto the image-forming medium to the size represented by the character size data; and

20

storage means for storing data representing the new rotational speed as data, at which first drive means should be rotated in order to form an image represented by the code data.

25

6. A method of forming an image, comprising

the steps of:

emitting a light beam in accordance with image data representing pixels arranged in a main scanning direction and a sub-scanning direction;

5 scanning an image carrier with the light beam in the main scanning direction by reflecting the light beam by means of a rotating polygon mirror;

10 rotating the image carrier, thereby moving a surface of the image carrier in the sub-scanning direction and forming an electrostatic latent image on the surface of the image carrier;

applying developer onto the image carrier, thereby to develop the electrostatic latent image into a visible image;

15 transferring the visible image from the image carrier onto an image-forming medium;

20 changing a rotational speed of the polygon mirror in accordance with an error in magnification in the main scanning direction, said magnification being determined from a size ratio of the visible image transferred onto the image-forming medium to an original document image and

25 changing a rotational speed of the image carrier in accordance with the change in the rotational speed of the polygon mirror.

7. A method according to claim 6, wherein the step of scanning an image carrier includes a step of

inputting a reference clock data and a step of rotating
the polygon mirror at a speed corresponding to
the reference clock data, and the step of changing
a rotational speed of the polygon mirror includes
5 a step of inputting data representing the reference
clock corresponding to the error.

8. A method according to claim 6, further
comprising a step of optically reading data printed on
the document sheet and providing the data, thus read,
10 as said image data.

9. A method according to claim 8, wherein the
step of optically reading data includes a step of
reading an image of a scale, and the step of changing a
rotational speed of the polygon mirror includes a step
15 of changing the rotational speed of the polygon mirror
in accordance with an error in magnification in the
main scanning direction, said error being determined
from a size ratio of the visible image transferred onto
the image-forming medium to an original scale image.

20 10. A method according to claim 6, which further
comprises a step of receiving facsimile data repre-
senting the image of the scale and supplying the
facsimile data as said image data, and in which the
step of changing the rotational speed of the polygon
25 mirror includes a step of changing the rotational speed
of the polygon mirror to a new rotational speed in
accordance with an error in magnification in the main

scanning direction, said error being detected from
a size ratio of the visible image represented by the
facsimile data and transferred onto the image-forming
medium to the original image of the scale, and a step
5 of storing the new rotational speed as data, at which
the polygon mirror should be rotated in order to form
an image represented by the facsimile data.

11. A method according to claim 6, which
further comprises a step of receiving code data from
10 an external apparatus, processing the code data into
font data representing a character having a size
represented by character size data added to the code
data and in which the step of changing the rotational
speed of the polygon mirror includes a step of changing
15 the rotational speed of the polygon mirror to a new
rotational speed in accordance with an error in
magnification in the main scanning direction, said
error being determined from a ratio of a size of the
character in the visible image represented by the code
20 data and transferred onto the image-forming medium to
a size represented by the character size data, and
a step of storing the new rotational speed as data at
which the polygon mirror should be rotated in order to
form an image represented by the code data.

ABSTRACT OF THE DISCLOSURE

After the digital copier has been assembled,
a magnification error is calculated. The magnification
error is a size ratio of a 100% copied image to an
5 original image. The main CPU of the copier changes the
rotational speed of the polygon-mirror driving motor to
a new speed, in accordance with the magnification error.
Further, the main CPU changes the speed of the main
motor for the photosensitive drum in accordance with
10 the new speed of the polygon-mirror driving motor.
Therefore, the magnification of any copied image can be
minutely adjusted by changing the rotational speed of
the polygon-mirror and photosensitive drum.

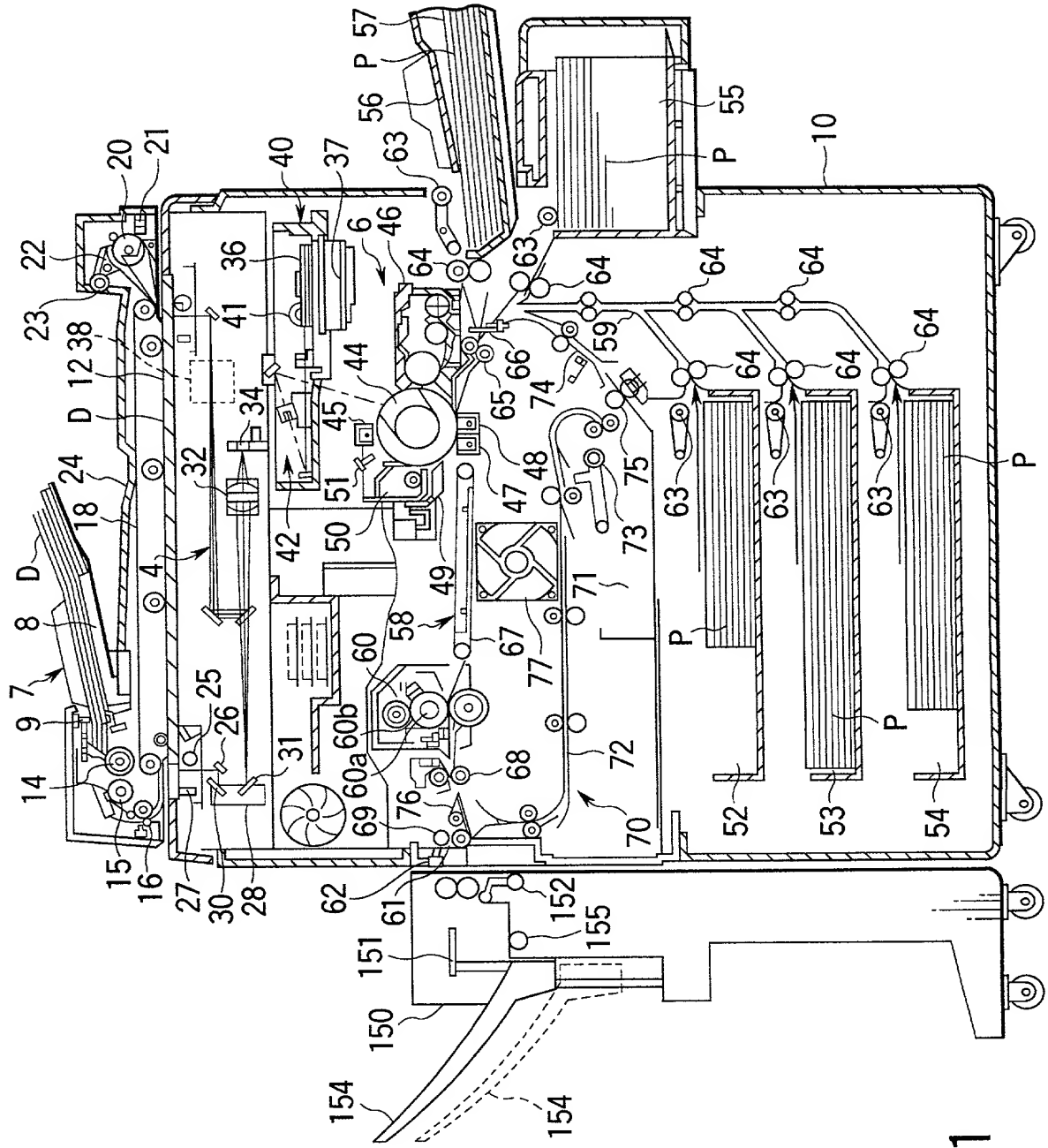


FIG. 1

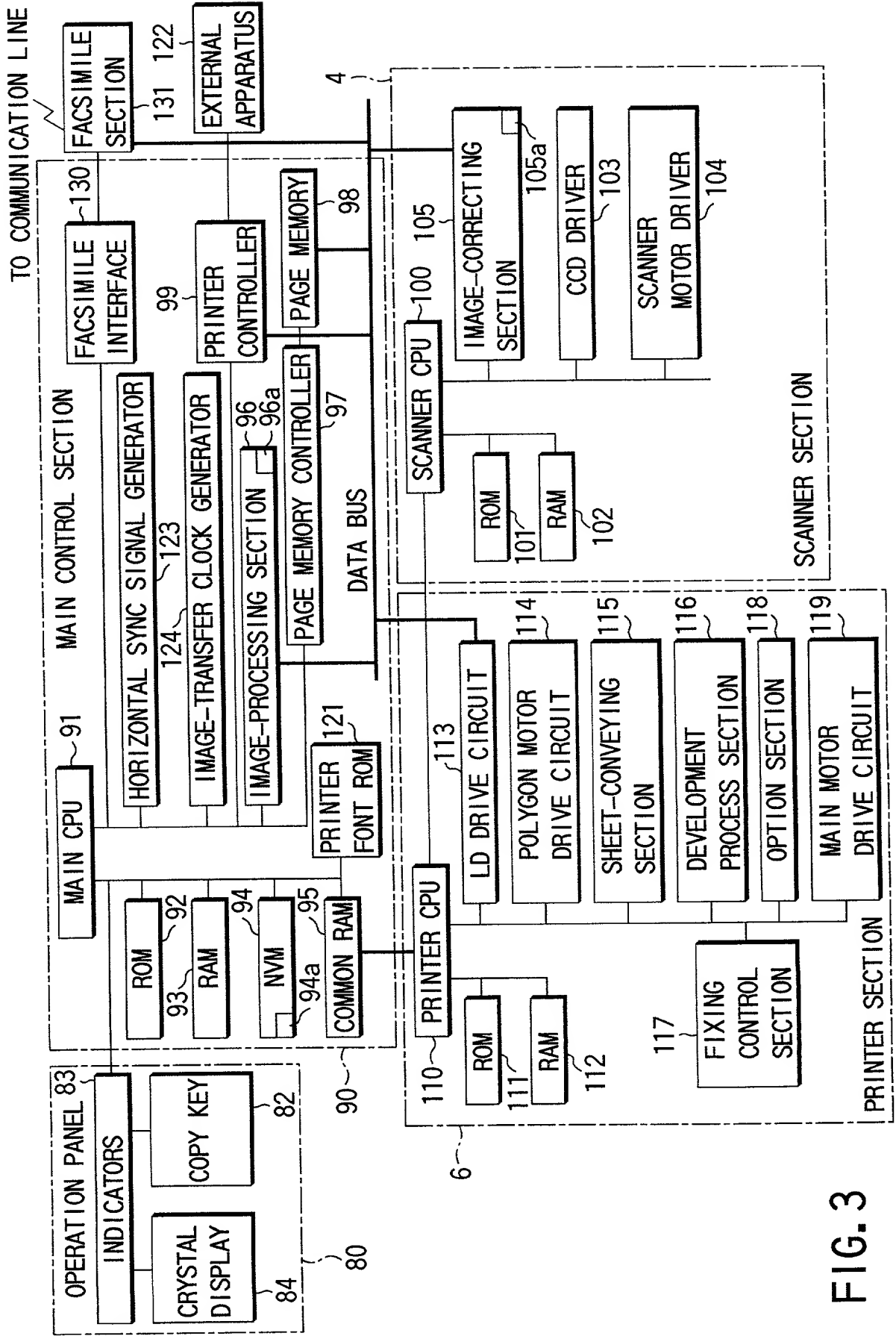


FIG. 3

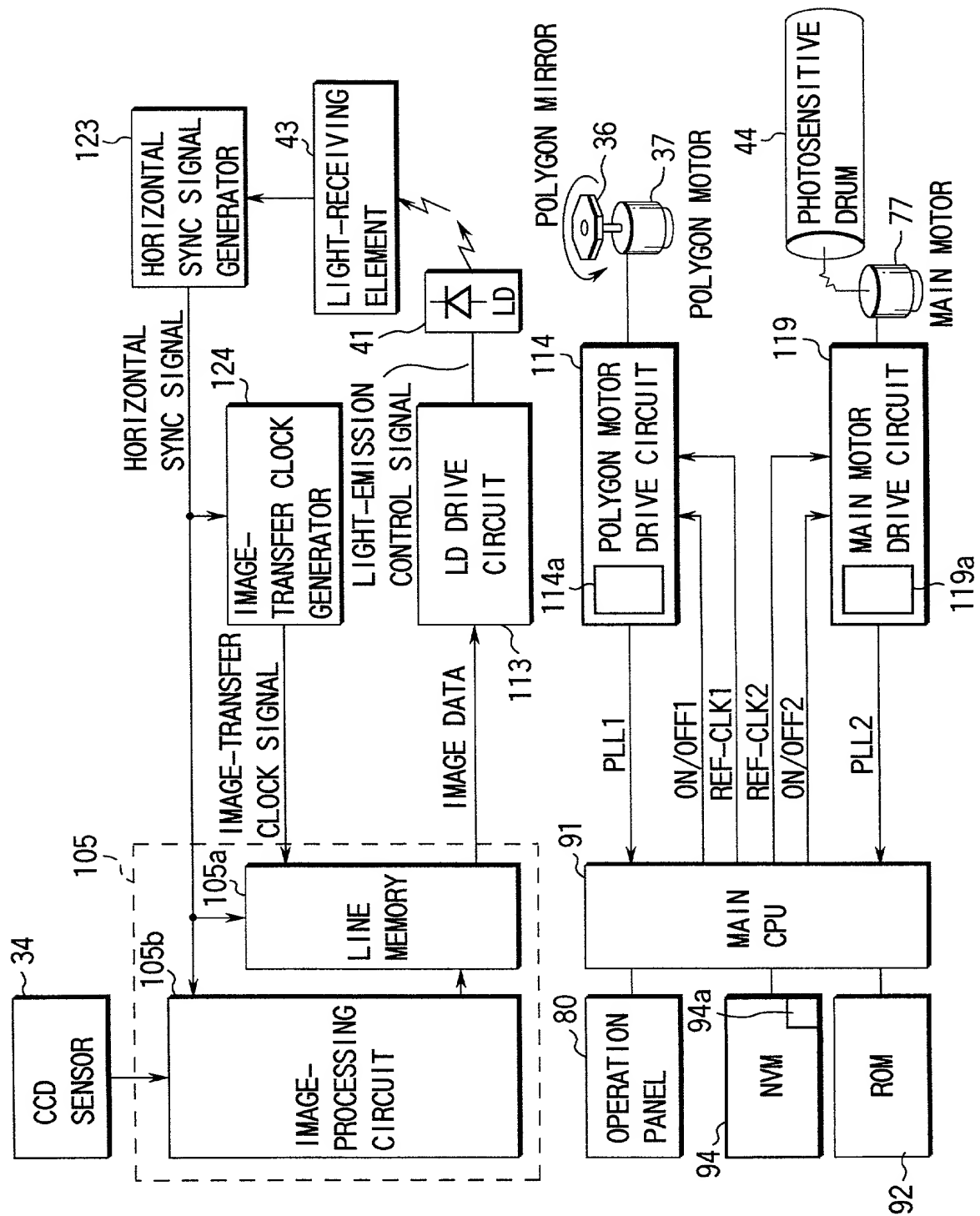
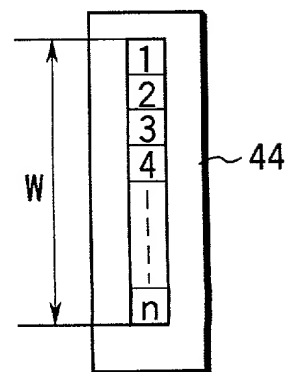
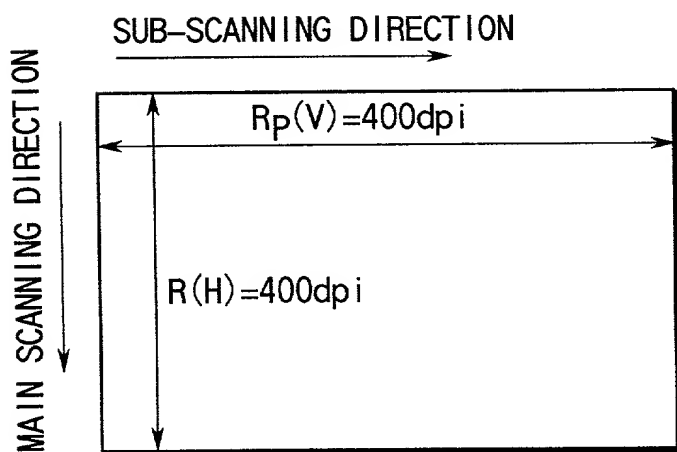
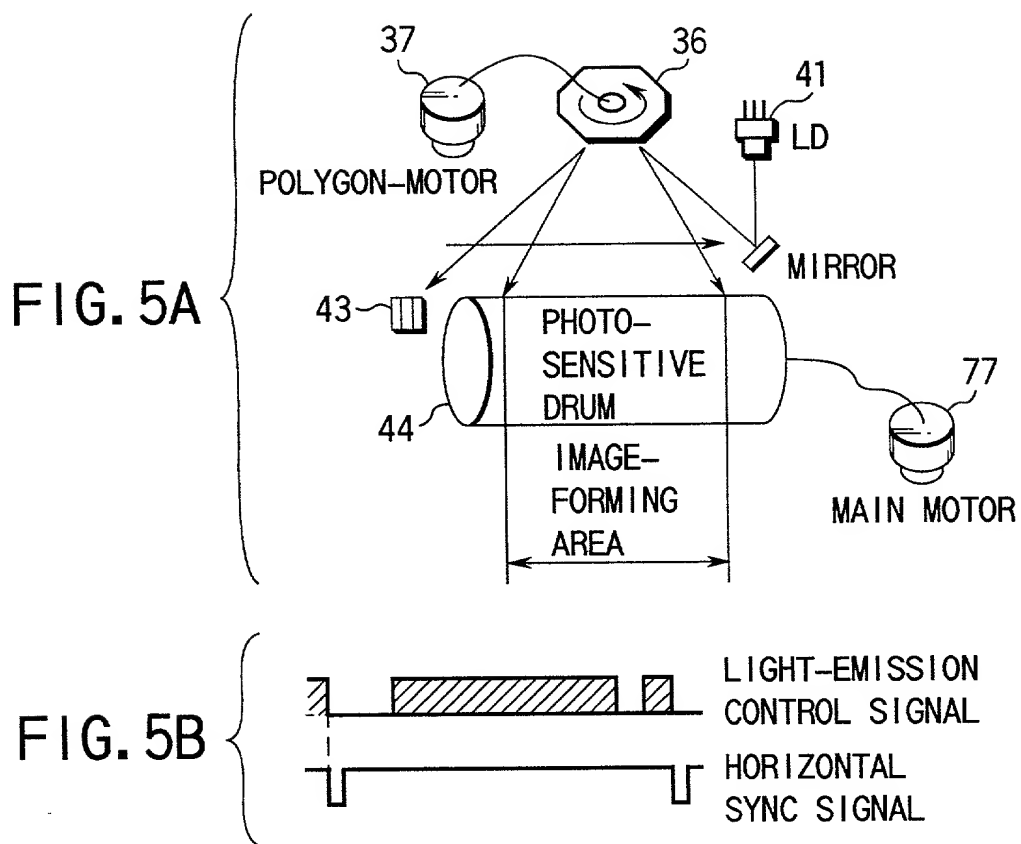


FIG. 4



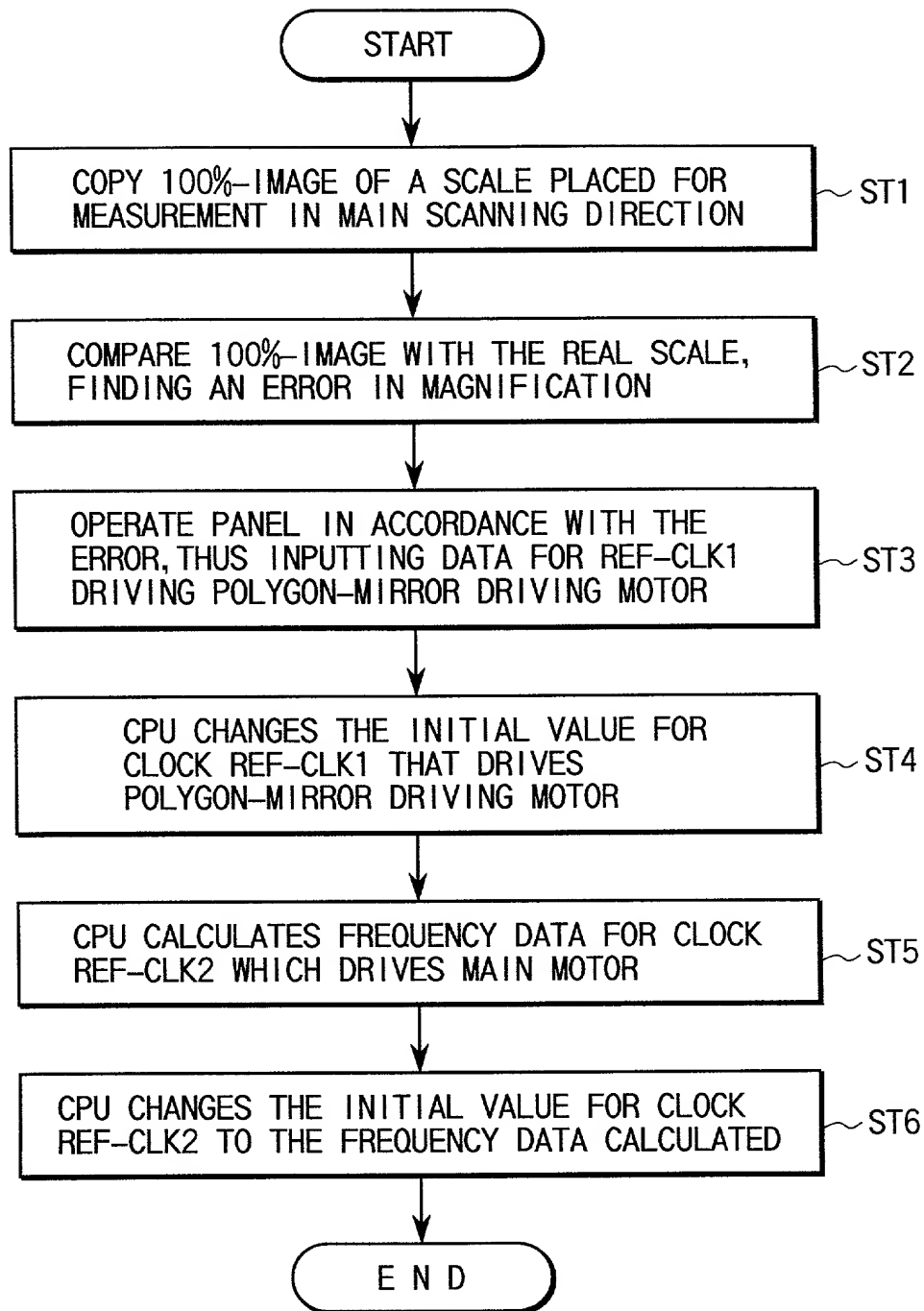


FIG. 7

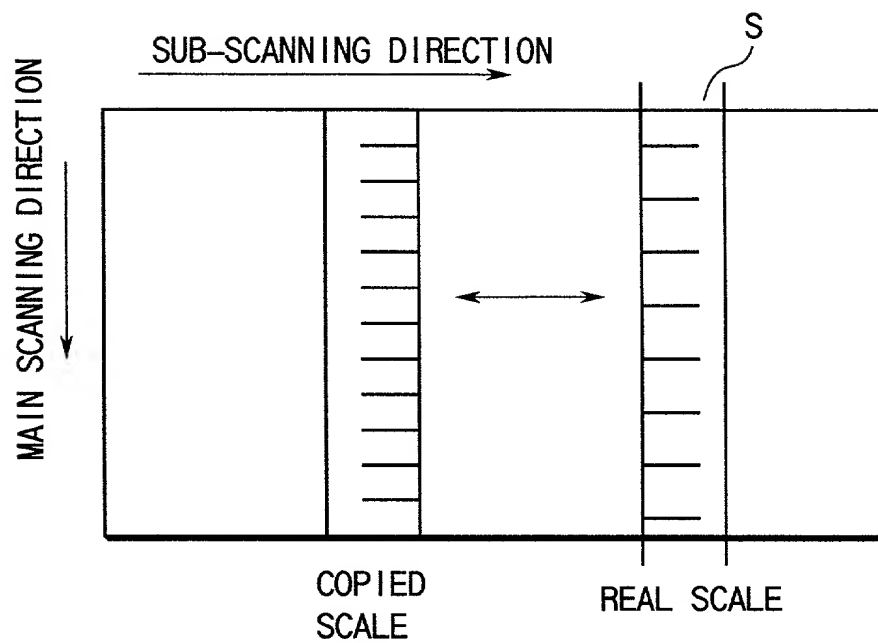


FIG. 8

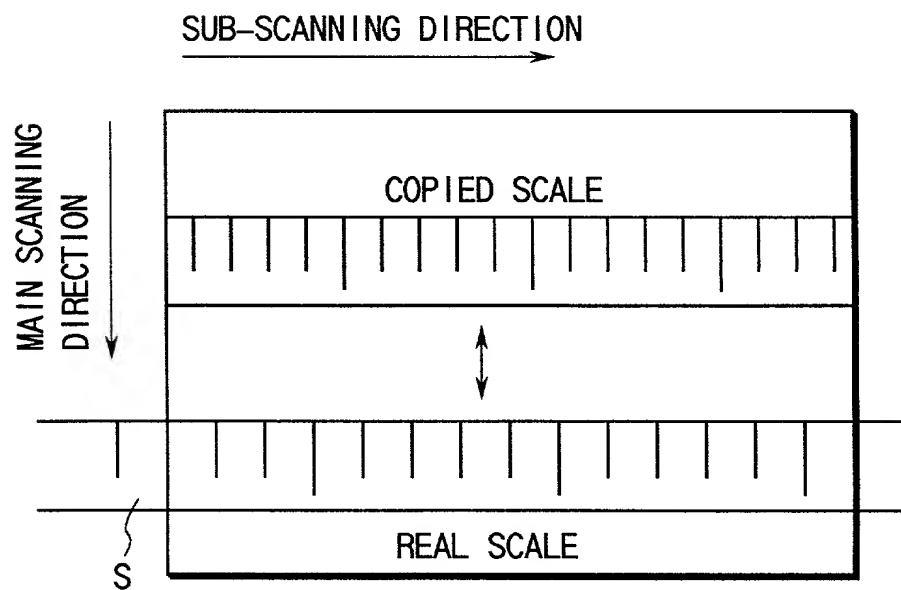
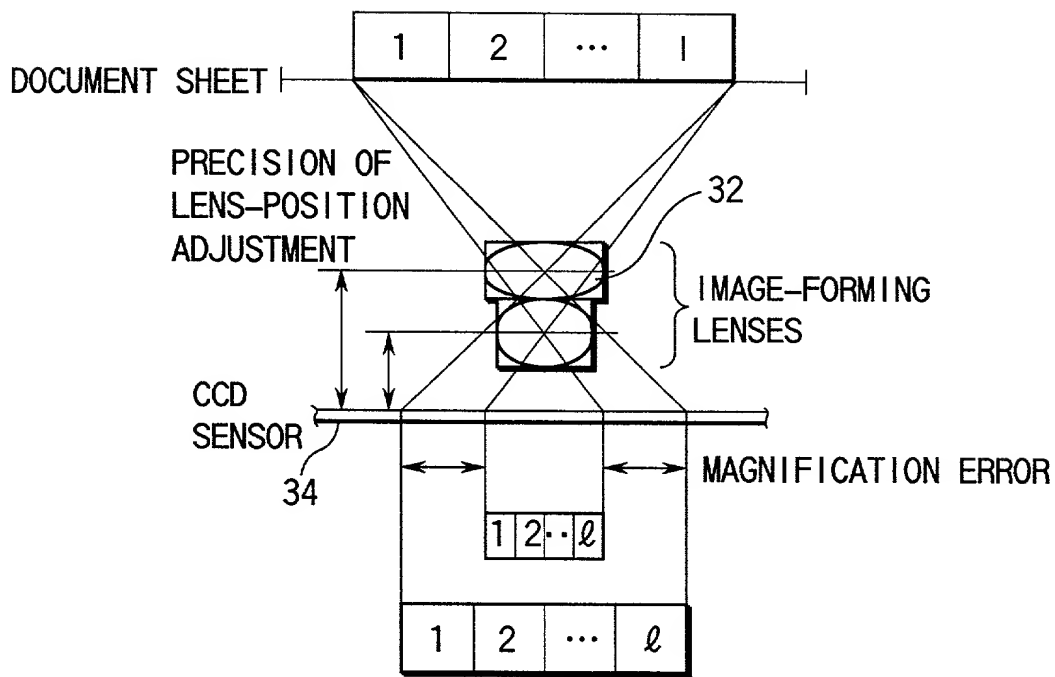
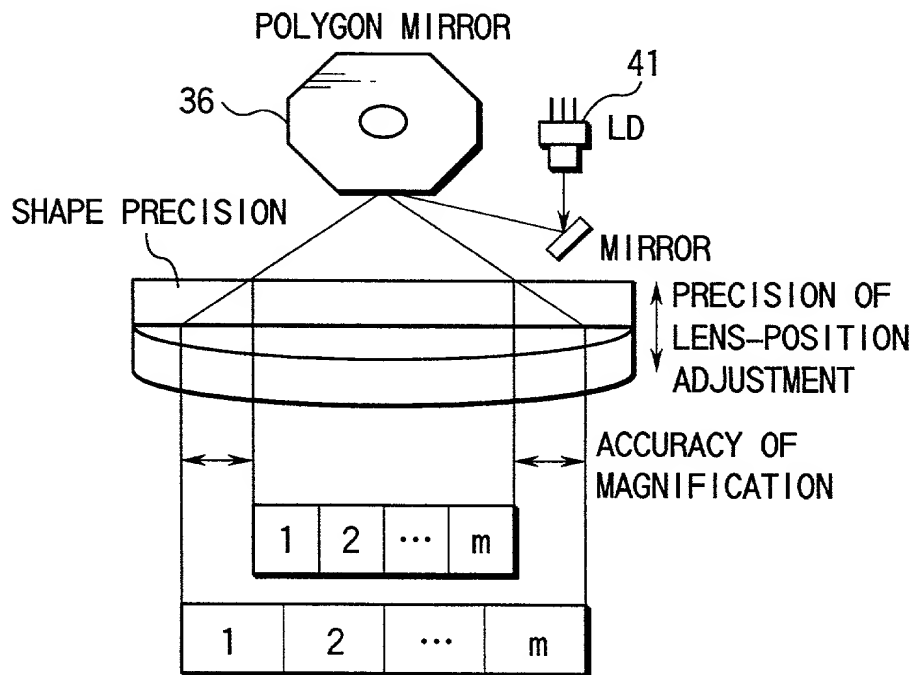


FIG. 9



· ERROR MADE IN READING OPTICAL SYSTEM

FIG. 10



· ERROR MADE IN LASER OPTICAL SYSTEM

FIG. 11

DECLARATION FOR PATENT APPLICATION

(98S1033)

As a below named inventor, I declare that my residence, post office address and citizenship are as stated below above my name; I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

IMAGE FORMING APPARATUS AND EXPOSURE SCANNING APPARATUS

the specification of which (check applicable box(es)).

☒ is attached hereto.

☐ was filed on
No.

as United States Application No. or PCT International Application

☐ and was amended on

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 35 U.S.C. 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed:

Japanese Patent Application No. 10-038979, filed February 20, 1998 Priority Claimed

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s) or 35 U.S.C. 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application or PCT International application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, which became available between the filing date of the prior application and the national or PCT international filing date of this application.

I hereby appoint as my attorneys, with full powers of substitution and revocation, to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: Stephen A. Bent (Reg. No. 29,768), David A. Blumenthal (Reg. No. 26,257), John J. Feldhaus (Reg. No. 28,822), Donald D. Jeffery (Reg. No. 19,980), Peter G. Mack (Reg. No. 26,001), Brian J. McNamara (Reg. No. 32,789), Sybil Meloy (Reg. No. 22,749), Colin G. Sanderock (Reg. No. 31,298), Bernhard D. Saxe (Reg. No. 28,665), Richard L. Schwaab (Reg. No. 25,479) and Arthur Schwartz (Reg. No. 22,115), each of whose address is Suite 500, 3000 K Street, N.W. Washington, D.C. 20007-5109, or any one of them, and request that correspondence be directed to Foley & Lardner, Suite 500, 3000 K Street, N.W. Washington, D.C. 20007-5109.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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